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in a broad-skulled or long-skulled direction, respectively.

The important point to note is that the descendants of a single ancestral titanothere or of any other vertebrate may become either brachycephalic, mesaticephalic or dolichocephalic; in other words, *the primitive mesaticephalic ancestral form of skull does not control the form of skull which may be derived from it, yet an evolution tendency once established is pursued to its limits.*

2. *Tooth Evolution through Rectigradations or Orthogenesis*

Here, in contrast to the foregoing cases of brachycephaly and dolichocephaly a law of hereditary ancestral control appears to be in operation. The diagrams in Fig. 3, *A, B,* represent the origin of cuspules in two independent families of Perissodactyla which also have sprung from a very remote common ancestor.

The types selected are (*A*) *Orohippus,* a Middle Eocene horse, and (*B*) *Palæosyops,* a Middle Eocene titanothere. The teeth represent the seven grinders of the lower jaw viewed from the internal aspect. Circles surround the new cuspules, which are appearing on the inner sides of these teeth. We observe that cusp for cusp exactly the same cuspules are arising in the jaw of *Orohippus* as in the jaw of *Palæosyops,* but that, although an animal of the same geological age, *Orohippus* is acquiring its new cusps a little more rapidly than *Palæosyops,* as shown in the following table:

	Palæosyops No. of Cuspules	Orohippus No. of Cuspules
First premolar	2	2
Second premolar	2	3
Third premolar	3	4
Fourth premolar	4	4
First molar	3	3
Second molar	1	1
Third molar	1	1
Total	16	18

This comparison proves that while there is apparently a law of ancestral or hereditary control operating in the genesis of these new cusps, and that while the new cusps are orthogenetic and hence may be termed "rectigradations" (because developing in fixed lines) *such law of ancestral control does not determine the rate of evolution of the cusps in these two types.* The *rate* of evolution is more rapid in *Orohippus* than in *Palæosyops.*

This observation appears to bar the hypothesis that the appearance of these cusps is due to an internal perfecting tendency which operates independently of external conditions and to favor the hypothesis that in some unknown manner external conditions control the rate of evolution, again illustrating the law of the four inseparable factors.

Conclusion

The contrast between the origin of changes of proportion illustrated in brachycephaly and dolichocephaly and the origin of new cuspules is, apparently, that the former is independent of hereditary control and not predetermined, while the latter is predetermined or under hereditary control. Both phenomena are controlled alike as to *rate of evolution* by adaptation to external conditions, namely, by the kind of food on which the animal subsists.

These considerations appear to me to sustain my hypothesis of the independent operation of two primary factors at least to produce an harmonious adaptive result.

Henry F. Osborn

THE FILLING OF EMERALD LAKE BY AN ALLUVIAL FAN

About four miles northwest of the town of Field, in British Columbia, and separated from it by Mount Burgess, lies the beautiful sheet of water known as Emerald Lake. Situated near the head of a broad glacial valley, this lake has been formed probably by the damming of the original channel by a heap of glacial débris, perhaps supported by a resistant outstanding ledge of bed rock at this place. Across this barrier the water has its exit.

The present interest in Emerald Lake, however, rests not so much upon its mode of formation as upon the fact that it is slowly being

filled in at its northern end by a large alluvial fan. Since the streams which feed the lake have their source in the snow and ice fields high up on the adjacent mountains, they are loaded with a considerable supply of rock waste, which, by reason of their swift descent down the steep mountain slopes, they can easily wash into the valley. But as soon as the water reaches the much gentler grade of the valley floor, a great deal of the material, which is too heavy to be borne farther, is dropped, the coarser near the foot of the cascades, the lighter at some distance. In spring, when the volume of the rivers is much increased, coarse fragments are swept farther down the valley than they are in the summer season. Furthermore, after the stream has raised its bed in one place, a freshet may cause it to break through its low walls and begin building in a new direction. Evidence of this swinging of the stream is abundant on the surface of the Emerald Lake fan, in the numerous forsaken channels that radiate from its feeding point, or origin.

The construction of the fan is carried on by *two* streams which unite near the head of the lake. That the west branch is the more efficient is proved by the fact that the east branch flows through a narrow marshy tract bounded on the east by the steep valley walls and on the west by the edge of the fan of the west branch. In other words, the latter has shoved the east branch against the eastern valley walls. Furthermore, the east stream has, near the base of its cascades, a small fan of its own.

There is no doubt, then, that the main fan is growing. At what rate this development is going on is not certain; but it must be relatively rapid, for, although trees of twenty or thirty years are found on many parts of the deposit, especially in the older portions, these are generally rather thinly scattered. Vegetation is scarce because there has been little or no rock decay.

Emerald Lake was described above as occupying a depression near the head of a glacial valley. We may add that the fan is in the northern half of this depression; that is, the lake and the fan together are situated in a single basin. This is very evident in the field, where the continuity of the bounding walls of both fan and lake is most conspicuous.

The northern border of the lake is marshy because the finer sediments of the fan are laid down here. Farther back these are being covered by coarser sand and pebbles. Hence a vertical section through the fan would be that of a typical lake basin, for in vertical succession the strata run from fine below to coarse above.

There are five facts, therefore, which indicate that the lake is being filled in by the fan. They are as follows: (1) the surface of the fan is dissected by channels of *recent* formation; (2) the weaker stream has been pushed against the valley wall; (3) the deposits are fresh, and the vegetation is consequently sparse; (4) the lake and the fan are in the same depression; and (5) the structural relation between the lake and the fan is that of a filling lake basin. The first three statements denote recent change, while the last two refer to the close connection between the sites of the water and of the sediments. To-day Emerald Lake appears to be about half its original size. How soon it will be crowded out of existence it is impossible to determine; but that it must eventually disappear, unless some unforeseen event occurs, seems inevitable.

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BOTANICAL NOTES

SEASIDE LABORATORY WORK

THE combination of recreation with study is so difficult in many places that it often seems an act of cruelty to urge tired teachers to engage in study during summer vacations. We work too hard for eight or nine months, so that rest of some kind is often absolutely necessary in order to avoid brain fag. No doubt it would be a wiser plan in schools and colleges for both students and teachers to work at a more leisurely rate, and to keep it up the whole year, as is done in other occupations, but as schools are conducted at the present time teachers and